May 27, 2016

National Remedy Review Board
San Jacinto River Waste Pits
EPA Region 6

Dear National Remedy Review Board Members,

The San Jacinto River Coalition (SJRC) is a community-led organization that serves the communities surrounding the San Jacinto River Waste Pits (SJRWP). Over 1,700 community members have signed onto the SJRC's efforts in the hopes of creating a better future for their children. Coalition members believe remedial alternatives other than full removal are merely band aids on the problem, leaving the region subject to future contamination.

These comments consider the remedial options in the context of the requirements of CERCLA and the National Contingency Plan. Protection of human health and permanence of the remedy are driving considerations.

> **"The National goal of the remedy selection process is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste."** 40 CFR 300.430 (a) (1)(i); See also 42 U.S.C. 9621.

Full removal is the alternative that best satisfies the goal stated above. Furthermore, it is the option that best satisfies the 9 evaluation criteria in the National Contingency Plan. (40CFR300.430(e)(9)). Alternatives involving enhancement of the current temporary cap FAIL to meet the criteria of overall protection of human health and the environment, long-term effectiveness and performance, community acceptance, or reduction of toxicity, mobility, or volume.

Information in the following reports, all completed after the problematic draft RI/FS documents for this site, contain important considerations relevant to remedy selection:

A Flood Risk Assessment of the San Jacinto River Waste Pit Superfund Site By Dr. Sam Brody, Ph.D. Professor and George P. Mitchell Chair in Sustainable Coasts. Director of of the Center for Texas Beaches and Shores. Texas A&M University Galveston

The San Jacinto River Waste Pits Superfund Site: An Assessment of Remedial Options for Sites with Dioxin-contaminated Sediments with Implications for Remedy Selection at the San Jacinto Site by Dr. Kathleen Garland, Ph.D. in Geology from Pennsylvania State University. Lecturer in Environmental Management at the University of Houston – Clear Lake
Assessment of the Occurrence of Cancer, East Harris County, 1995-2012, June 19, 2015, Prepared by the Texas Department of State Health Services

Fundamentally, the basic choice is between enhancing the existing temporary cap and removing the waste. Though the temporary cap has slowed the release of highly persistent and toxic waste from the Pits, it is clearly not a viable long-term solution for this waste. Failures and shortcomings in this cap in the mere 5 years since it was installed confirm its inadequacy.

Information from both the EPA and other sources indicate that this waste doesn't degrade, and likely will remain toxic for a minimum of several hundred years. The SJRWP site is located in a tidally influenced estuary in an area of high flow velocities that does not conform to EPA's *Guidance for In-Situ Subaqueous Capping of Contaminated Sediments.* A cap simply is an inappropriate remedy considering the toxicity and persistence of the waste and the site's location.

Dr. Garland's report identified seven similar estuarine Superfund sites across the United States. The EPA required removal of the highest concentrations of contaminated sediment at *all* seven sites. Subsequently, additional riverine Superfund sites have been identified to our organization where removal of similar contaminants was (or is being) required.

The waste in the Pits is fairly contained in an accessible, shallow location, making clean-up feasible and less complex than other locations where removal has been accomplished. The Coalition asks the EPA to fully remove the northern impoundment by employing best management practices to isolate the Site from the River, dewater the Site, excavate the waste, and haul the waste to a permitted and stable storage facility. This letter focuses more on the northern area, much of which is submerged. Significant releases into the environment occurred from this area before the installation of the temporary cap, and it continues to be most vulnerable. The southern impoundment, which is primarily upland, also needs to be addressed, considering the very high levels of contaminants that have been found in that area.

The community members of Harris County, just as anywhere else in the United States, deserve clean air, clean water and clean soil. It is time to fully remediate this once pristine and highly sought after river. A remedial solution should be one that allows the surrounding communities and ecosystem to sustain and flourish and not be subject to further contamination.

Stakeholders – The Community and the Ecosystem

The San Jacinto River Waste Pits are located in a residential area of rapid development, which is projected to double by 2040. It is estimated that if the Pits were left in place, the dioxin would not degrade for 750 years- that is the year 2766. The nearest residential home is 0.45 miles from the northern impoundment and is less than 10 feet above mean sea level. Approximately 16,700 people live within a 5-mile radius of the Waste Pits (Brody, 2014). The three towns nearest to the site are Highlands, Channelview and Baytown. These communities are home to over 112,000 people.

Distributed throughout a 5-mile radius of the SJRWP are demographics particularly vulnerable to dioxin exposure; elderly and children. The community directly east of the site has a disproportionate amount of children under the age of 5 years old. Between 14.3-18.9% of this community is under the age of 5 years old. Not only are the elderly and children "most sensitive to dioxin exposure, but also have the most difficult time evacuating and recovering from a flood event, further exacerbating the adverse impacts to this segment of the community. That said, exposure to the dioxins could potentially

occur without the presence of a major storm due to the documented potential for chemical leakage" (Brody, 2014).

Within three miles of the waste pits are two public water parks and two public beaches. These locations are popular swimming attractions to people from all over Harris and surrounding counties. Within two miles of the waste pits, there are six public boat ramps. People from all over the country travel to RV parks located in Highlands, some of which are directly on the river and encourage fishing. Many visitors to the area are unaware of the advisories and risks associated with the seafood they catch. This has been confirmed by the Texas Department of State Health Services, as they try to reach out to those found fishing in the area.

The San Jacinto River flows into Galveston Bay, one of the most delicate and productive estuaries in the United States. Almost 30% of Galveston Bay's fresh water is supplied from the San Jacinto River. The San Jacinto River and Galveston Bay provide a unique habitat for a myriad of different species to spawn and flourish.

Through this Superfund process, Texas Department of State Health Services and the EPA have found it difficult, if not impossible, to limit the fishing and use of the river near the waste pits. Many community members fish the San Jacinto River to supplement their food supply, and there is evidence of subsistence fishing in this area. While there are seafood consumption ADVISORIES in this area that recommend that children and women of childbearing age do not consume seafood from this area, and limit others to one meal a month, there is no enforceable limitation on fishing near the site. It is believed that some of the fish caught in that area also enters the commercial market, putting unsuspecting consumers far from the site at risk.

The area around this site also has a substantial minority population, raising environmental justice issues. We understand that other interested stakeholders likely will expand on this concern.

Another community concern is whether contaminants entered the drinking water system. It is not clear that this concern has been adequately evaluated. Nearby municipalities mix at least 20% groundwater with surface water, and according to the City of Houston Public Works, there are 1,424 private groundwater wells within a 5-mile radius of the Pits. The nearest municipal water well is 1.8 miles from the Waste Pits. The nearest private groundwater well is 0.39 miles from the Pits.

This being said, the only effective way to truly protect human health and prevent further exposure to dioxin and other toxic chemicals from the SJRWP, is to fully remove the toxic waste.

Site Vulnerabilities

Coastal Storms and Flood Events

The San Jacinto River Waste Pits are located on one of the world's most threatened coasts. According to marine geologist John B. Anderson of Rice University, "Nowhere on earth does the impact of humans and natural forces pose a greater threat to coasts than in Louisiana and Texas". The San Jacinto River Waste Pits are located in a vulnerable and delicate setting, which is crucial to consider during the selection of a remedial alternative.

A *major* hurricane makes landfall on the upper Texas coast, on average, every 6 years according to the National Oceanic and Atmospheric Administration. Eight hurricanes have caused extensive damage to the upper Texas coast since 1959. The gentle slope of the continental shelf below the Gulf of Mexico and the warm Gulf waters provide an inviting setting for a hurricane. So inviting, in fact, that a tropical storm or hurricane hits the Texas coast every 2.68 years. When a major hurricane strikes the Texas coast, it has the potential to bring 12 inches of rain a day, a surge of 20 to 30 feet and cause flooding as far as 150 miles inland (Anderson, 2007). In 1962, Hurricane Carla's storm surge pushed large rocks inland from 50-80 ft deep in the Gulf and dunes retreated as far as 100 ft. According to Professor Phillip Bedient of Rice University, "Severe tropical cyclones have been recorded in the region since the 1850s; such storms bring severe storm surge that can travel through Galveston Bay and in the San Jacinto River. Combined with overland runoff, the impacts on the water levels in the San Jacinto River are devastating. Flooding due to inland rainfall, however, is much worse at this location. During the major flood of 1994 on the San Jacinto River, elevations exceeded 27 feet and created scouring flows and velocities." During the 1994 incident, there was a major spill and fire, as submerged pipelines were scoured out and failed. When one considers the site's location, its toxicity, and the risk of hurricanes, leaving the waste pits *in situ* is a catastrophic disaster waiting to happen.

Historical flood data of both freshwater flooding and storm surges should be seriously considered in the selection of a remedial alternative. "It should be noted that the San Jacinto waste pits are also vulnerable to damaging high-peak flows from regional runoff. Frequent large rainfall events can easily submerge the waste pits, causing them to overtop their levees and possibly spill contaminants into the San Jacinto River. Historical crest records from a USGS gage indicate that the waste pits have been exposed to potentially high-scouring flows at least 27 times since 1973 (Bedient, 2013). During these events the waste pits can remain submerged under water for days at a time" (Brody, 2014).

According to Rice University's Severe Storm Prediction, Education, and Evacuation from Disasters (SSPEED) Center, the significance and destructive force of hurricane storm surges are not fully appreciated and their destructiveness and power are seriously underrepresented in engineering literature. Hurricane surges, combined with rainfall, are an under-examined phenomenon and pose a worsening risk to the Houston area (Blackburn and Bedient 2010).

According to Dr. Brody, "Flooding via storm surge is the major threat to the waste pit site and surrounding properties. The position of the site close to the mouth of a river or freshwater inflow makes it especially vulnerable given the mechanics of a storm surge. **There are actually two inundation events: first, the initial rise and pulse of water inundating the waste pit site; second, the backwash of water as the surge releases back into Galveston Bay and ultimately the Gulf of Mexico. The intense tidal flushing can essentially deliver a "double dose" of pollutants to upstream residents, as well as a single downstream dose as the water returns to the Bay. Based on the NOAA hurricane surge inundation zones, the waste pit site would be inundated by any hurricane and tropical storm due to its low elevation and vulnerable location. Given its vulnerability, the site will almost certainly experience repetitive erosive surge events in the coming years, further degrading the structural integrity of on-site protective devices**."

An example of the potential destruction when Superfund sites receive a visit from natural forces can be found in Ecological Economics (Gaddis, 2009). This report notes there were 26 Superfund sites in the path of Katrina and that massive amounts of toxic wastes, oil and debris were dispersed by the

hurricane, greatly impacting the environment and aquatic ecosystems. In one example, Hurricane Katrina's winds and surge were strong enough to topple a 250,000 barrel metal storage tank, causing a large oil spill. This example shows the power of hurricanes to disperse toxic chemicals stored in their path. In addition, a Superfund report by the Government Accountability Office, points out that cleanup costs from hurricanes and natural disasters that spread toxic wastes are high and often result in new Superfund sites.

Subsidence

Unlike other coasts along the United States, the Gulf Coast is positioned along a large sedimentary basin, which lacks bedrock to support the overlying strata and development. Due to this geologic setting in combination with overdevelopment and extraction of natural resources, the USGS has named the Texas coastline the fastest submerging coast in the US. Subsidence is a historical problem for Houston and must be considered when determining a long-term solution for the northern and southern impoundments.

Much of the SJRWP site has subsided into the San Jacinto River and submerged at all times, with additional varying amounts submerged depending on tidal conditions.

Since the 1940's, over 100 acres of land near the SJRWP site have subsided into the San Jacinto River. The former Brownwood subdivision is roughly three miles south of the waste pit, was inundated in 1961 when Hurricane Carla struck the Texas coast, and the neighborhood was inundated, condemned and displaced following Hurricane Alicia in 1983.

Barge Activity and Interstate 10 Considerations

In the immediate vicinity of the San Jacinto River Waste Pits are four large shipyards and barge facilities. Tug boats, barges and privately owned boats navigate past the site on a regular basis. Any given day residents can count upwards of 70 barges in the immediate vicinity of the Pits. The U.S. Army Corps of Engineers (USACE) estimates there is about a 1 in 100 probability of a significant strike and about a 1 in 12 probability of a minor strike within a given year. Due to heavy barge traffic in close proximity to the Waste Pits, we feel that the probability of a strike is greater than the USACE Report estimates.

Interstate 10, a major federal highway straddles the SJRWP site between the northern from the southern impoundments. The vulnerability for barge strikes in this area is further confirmed by the 5 dolphin bridge protection structures directly across the river channel from the northern impoundment. The structures were constructed in 2006 by the Texas Department of Transportation to protect the Interstate 10 bridge from a barge strike. However, nothing of such magnitude is in place to protect the northern impoundment from the same threat.

Very recently, we learned that these large (about 35 ft diameter) dolphin structures were installed by creating cofferdams with sheet piling and excavating the inside areas. Why would the agency go to the expense of installing these if there weren't appreciable risk of strikes capable of damaging the bridge, which is a much sturdier structure than the temporary cap? Also, the construction approach used was similar to alternatives recommended for removing the waste at the site.

Additionally, as some point in the future, Interstate 10 will be need significant maintenance work or will need to be expanded. Keeping the current temporary cap and the waste in place would significantly complicate and add expense to such a major project.

Cancer Incidence Concerns

The focus of the NRRB is evaluating remediation options. However, a major goal in making such decisions is "protection of human health." The risk assessments and public health assessment documents for this site were based on theoretical exposure values tied to testing data. There was no real evaluation of cancer or disease incidence in the nearby communities, and no surveys or studies conducted in the community.

In 2015, the Texas Department of State Health Services issued its assessment of the occurrence of cancer in East Harris County. This investigation and report "was not intended to determine the cause of observed cancers or identify possible associations with any risk factors." However, we believe some of the results raised concerns potentially associated with the SJRWP site.

"Observed numbers of several of the 17 cancers analyzed were statistically significantly greater than expected." (TDSHS 2015) The number of cancer / census tract combinations that were statistically significantly high exceeded the number that were statistically significantly low by a ratio of 3:1. The following types of childhood cancer had Standardized Incident Ratios (SIR) of greater than 2 in at least one of the census tracts in East Harris County: brain, leukemia, glioma, melanoma, and retinoblastoma. SIRs of greater than 2 were found in some census tracts for the following cancers for all ages: brain, male breast, cervix (5 different tracts between 2.02 and 4.81) and liver.

Of particularly concern is the incidence of childhood retinoblastoma, a rare eye cancer, with an SIR of 16.40 in the census tract closest to the SJRWP site, and SIR of 14.35 in another census tract in the study area. Incidence rates for cancer of the cervix and kidney for "all ages" also were high in the census tract nearest the site. Determining how to further investigate the results of this report has been problematic. Conducting a full epidemiological study of the community was rejected, and other alternatives aren't being actively pursued as far as we can determine. **While a direct cause-and-effect relationship with the SJRWP site can't be confirmed at this time, neither can it be excluded.**

Cap Fails to Maintain Protection over Time

The temporary cap supposedly was designed to withstand a 100-year flood event, which we have not experienced in recent years. Yet the cap has undergone several repairs and has failed to meet design expectations during the 5 years it has been in place.

Most concerning was the 25x22ft deficiency in the temporary cap discovered in December of 2015, which validates concerns that the cap is insufficient in the long-term. These concerns are strengthened by the uncertainty of how the deficiency was created or when.

Sediment samples grabbed near the deficiency referenced above confirmed upwards of 43,000ppt of dioxin openly exposed in the River, further supporting the concern that containment is not a solution.

Conclusion

The only way to truly protect human health and the environment from dangers associated with the San Jacinto River Waste Pits is to fully remediate the site. The San Jacinto River Waste Pits are located in a delicate setting; vulnerable to freshwater flooding, coastal storms, tidal surges, subsidence, sea level rise and barge activity. For over 40 years the Waste Pits were left unattended and exposed to local environments. The people and animals of Highlands, Channelview and Baytown have borne the burden of the local environment for far too long. At the May 25, 2016 EPA Open House, the audience was asked for a show of hands of who supports full removal and nearly every hand was raised.

Fully remediating the Waste Pits removes the potential for the financial burden to fall on taxpayers. According to U.S. Secretary of State, John Kerry, "For every dollar spent on a mitigation project, a savings of four dollars will be experienced." The surrounding communities do not want to push this hazard onto future generations. If the San Jacinto River Waste Pits are not fully remediated now, the surrounding communities, ecosystem and tax-payers will ultimately pay. It is not a matter of "if" a significant hurricane strikes the upper Texas coast; it is a matter of "when" a significant hurricane strikes the upper Texas coast. In this event, we do not want to suffer the burden of the toxic waste from the San Jacinto River Waste Pits.

This site is located in a residential area with vulnerable and increasing population The only remedy that provides "protection over time" for the centuries and possibly millennia that this waste presents risks to human health is removal from this active river environment. With the use of best practices, this remedy has been implemented safely at other sites, and should be implemented here.

For more information or copies of materials referenced in this report, I can be reached at (281) 414-3194 or jyoung@txhea.org.

Thank you,

Jackie Young
Executive Director
San Jacinto River Coalition

Lisa Gossett, Associate Professor and Program Chair of Environmental Management at The University of Houston- Clear Lake, also participated in the writing of this letter. This letter does not express official views or opinions of the University of Houston- Clear Lake.

ATTACHMENT – Excerpts from Reports

Excerpt from A Flood Risk Assessment of the San Jacinto River Waste Pit Superfund Site By Dr. Sam Brody of Texas A&M University Galveston- Center for Texas Beaches and Shores

CONCLUSION

The San Jacinto Waste Pits are located in an area that is vulnerable to many different physical threats: hurricane surge, wave action, riverine flooding, subsidence, and sea level rise. These forces, over time, have eroded the sediment and embankments around the site, which are likely the primary reasons for the eventual leakage of the toxic chemicals into the surrounding environment. The threat of human exposure when this site was built during the 1960's was much lower than it is today. Historical development has rapidly increased the amount of people that live within a few miles of the site and this trend is projected to continue well into the future.

More serious attention needs to be given to the local socioeconomic and built environment characteristics of this hazardous site. The threat of future surge and riverine flood events coupled with a changing climate and increasing development all have a ratcheting effect on the amount of impact this superfund site could inflict on surrounding communities. As risk of failure increases so too does the risk of exposure from flood-induced water vectors. Bioaccumulation is already occurring exposing local fisherman and residents to harmful chemicals that consume the fish and crabs. Sediment contaminated with dioxins could potentially be scoured from the site and transported into neighboring residential areas, school and wastewater management facilities, and a reservoir that provides drinking water. That said, the installation of the temporary geomembrane by the EPA is a first attempt to prevent leaking and exposure, but this is likely the first of many repairs that are likely to occur due the vulnerable location of this site.

Based on the flood risk assessment above, it is my expert opinion that the waste pits should be fully removed as outlined by Alternative 6 in the Feasibility Study conducted for CIMC and International Paper, Inc. (Anchor QEU, 2013). As already mentioned, the site is in an extremely vulnerable location to repeated inundation, which will only increase in the future. There is insufficient evidence that any proposed on-site remediation alternative can effectively stabilize the pits over the long term and prevent the leakage of contaminants to surrounding areas. The information contained in this report provides a more complete understanding of the flood risks associated with the site and can offer guidance to decision makers as they contemplate future mitigation actions.

Excerpt from <u>The San Jacinto River Waste Pits Superfund Site: An Assessment of Remedial Options for Sites with Dioxin-contaminated Sediments with Implications for Remedy Selection at the San Jacinto Site</u> by Dr. Kathleen Garland

The seven cases summarized for this report share four characteristics with the SJRWPs which allows them to be compared:

1. COCs include dioxins, PCBs, and mercury; and,
2. COCs are present in riverine, estuarine, or shallow marine sediments; and,
3. Environmental conditions at the site include subaerial and subaqueous exposure of contaminants in a tidally-influenced, estuarine or shallow marine environment; and,
4. Consumption advisories for fish and/or shellfish based on the increased risk of cancer and/or developmental defects for individuals consuming the contaminated seafood have been implemented in adjacent waters.

Analysis of these cases leads to the following conclusions:

A. In all cases, remedy selection for dioxin-contamined sediments included physical removal of the most highly contaminated sediments unless such removal would cause channel or bank instability.
Implications for the SJRWP: Such a removal appears to be feasible at the SJRWP site.

B. In all cases, selection of sediment removal as a remedy was based on a Human Health Risk Assessment which demonstrated that the site posed an elevated cancer risk to humans through the consumption of contaminated fish and shellfish. The Human Health Risk Assessments at these sites were conducted **PRIOR TO** any removal actions taken to reduce the immediate threat of exposure from the principal threat wastes at the site.
***Implications for the SJRWP*:** Such a pre-existing risk assessment does not exist for the SJRWP site, but extreme risk can be inferred from EPA's requirement that emergency action to protect human and environmental health be taken at the site in 2009.

C. In all cases, areas of lower-concentration, dispersed contamination were capped.
Implications for the SJRPW: The SJRWP site includes areas of such dispersed contamination that should be considered for capping to prevent further dispersion into the San Jacinto River and Galveston Bay systems.

D. Remedy selection in all the cases studied conformed to EPA's policy on management of principal threat wastes as stated in the National Contingency Plan (40 CFR 300.430(a)(1)(ii)).). That policy can be summarized as:
"EPA expects to use treatment to address the principal threats posed by a site, wherever practicable…," including "…liquids, areas contaminated with high concentrations of toxic compounds and highly mobile materials.
EPA expects to use engineering controls, such as containment (*n.b. which includes capping*), for waste that poses a relatively low long-term threat or where treatment is impracticable.
EPA expects to use a combination of methods, as appropriate, to achieve protection of human health and the environment…" (40 CFR 300.430(a)(1)(ii)).
In addition, EPA has recently released guidance on calculating cleanup levels at dioxin contaminated sites which states, "…preliminary site cleanup goals for dioxin-contaminated soils should consider 50 ppt (parts per trillion) for residential soils and 664 ppt for industrial/commercial soils as recommended values to be used in order to be protective of human health and the environment." (USEPA February 2012)

Implications for the SJRWP: The preferred remedy for the site as proposed in the RI/FS by the PRPs does not conform to this policy, as it specifies reinforcement of the current cap and added institutional controls as the remedy. Caps do not qualify as "treatment" for principal threat wastes under the National Contingency Plan criteria; such containment strategies are only acceptable for areas of lower-threat wastes. According to the NCP, the existing impoundments and surrounding highly contaminated wastes should be "treated" in order to permanently reduce toxicity at the site, and surrounding lower-level wastes should be contained to prevent further dispersion. Because of the nature of the contaminants at this site, the chosen treatment must be removal, as no other options exist to reduce the toxicity of these COCs to the levels recently proposed in EPA's guidance for cleanup levels at dioxin-contaminated sites.

Appendix

1)EPA Region 10 Memo (May 2010): McCormick and Baxter Creosoting Co. (Oregon)(http://yosemite.epa.gov/r10/nplpad.nsf/epaid/ord009020603)
This superfund site resulted from an abandoned wood treatment plant in the Willamette River near Portland Oregon. The site contained PCBs and heavy metals in a part of the River used for recreational activities and surrounded by residents. EPA first ordered capping, but when dioxin was later discovered, ordered excavation and removal of the waste off site to protect the public's health. The site was then capped.

2) EPA Region 10 Memo (December 2011): Wyckoff Company and Eagle Harbor (Washington)(http://yosemite.epa.gov/r10/nplpad.nsf/epaid/wad009248295)
This superfund site was caused by an abandoned wood treatment plant on an island in Puget Sound, which is partially underwater. Contamination includes PAHs, heavy metals, and dioxins. Two thousand residents live within a mile of the site, which is surrounded by commercial and residential sites. EPA has ordered excavation and removal, treatment, capping, and tidal barriers and walls to protect the public health.

3)EPA Region 10: Pacific Sound Resources(Washington) (May 2010)(http://yosemite.epa.gov/r10/nplpad.nsf/epaid/wad009248287)
This superfund site lies underwater in Puget Sound and on a bay shore and results from an abandoned wood treatment plant containing PCPs, PCBs, and heavy metals. Primarily in an industrial area, it also contained nearby residents, recreational use, and contaminated seafood that was being consumed. EPA ordered excavation and removal of 10,000 cubic yards of wastes, a slurry wall, sophisticated capping, and groundwater monitoring.

4) EPA Region 1: Centredale Manor Reclamation Project(Rhode Island)(2013)(http://yosemite.epa.gov/r1/npl_pad.nsf/51dc4f173ceef51d85256adf004c7ec8/bbe0100a535e8840852576e90053b186!OpenDocument)
This nine acre superfund site, from a variety of abandoned industrial plants, sits on a former apartment complex property and drains into the Woonasquatucket River in North Providence. The River is used by anglers, residents, and recreational users and is contaminated from the site by dioxins, furans, and PCBs. To protect the public health and environment, the EPA has order a $104 million clean-up, including 2 interim caps, excavation and removal of contaminated soil and sediment, rebuilding of a dam, restoration of the ground to its natural state, and wetland mitigation.

5) EPA Region 1: Loring Air Force Base (Maine)(2013)(http://yosemite.epa.gov/r1/npl_pad.nsf/f52fa5c31fa8f5c885256adc0050b631/01550369A32B31BB8525691F0063F6D6?OpenDocument)
This superfund site is an abandoned military base, containing PCBs, benzene, and chlorinated organic chemicals that flow into a drainage ditch and stream that contaminates the sediment and groundwater. In a rural area, 1500 residents live within a mile of the site. The EPA has ordered excavation and removal of 150,000 cubic yards of soil, capping of that waste, stream restoration, and in situ treatment of toxic wastes.

6) EPA Region 5: Ashland/Northern States Power Lakefront (Wisconsin)(2014)http://www.epa.gov/region5/superfund/npl/wisconsin/WISFN0507952.html)
This superfund site results from an abandoned water treatment plant in a mixed residential and recreational area. It consists of 12 acres of organic chemicals and PAHs, causing groundwater and lakefront contamination. Because the site is subject to wave action from boat and other uses, the EPA has ordered excavation and removal, water treatment, and water barriers.

7) Public Interest Research Group, Empty Pockets: Facing Hurricane Katrina's Cleanup with a Bankrupt Superfund (December 2005), pp. 5, 13-22, 23-27. (http://www.uspirg.org/sites/pirg/files/reports/Empty_Pockets_USPIRG.pdf) This report reviews the devastating impact of hurricanes, tornados, and other unpredictable natural disasters on existing superfund sites. It explores the resulting serious secondary economic, environmental, and health damages as well as the huge taxpayer-borne costs. The report points to a number of superfund sites impacted by hurricanes, flooding and other natural disasters, including the superfund sites of the American Creosote Works (Florida), Bunker Hill Mine(Idaho), South Eighth Street Landfill (Arkansas, Lower Darby Creek (Pennsylvania), and Mohawk Tannery (New Hampshire). It also discusses the enormous amount of toxic wastes from superfund and industrial sites dispersed by Hurricane Katrina, with potentially serious environmental and health harm as well as taxpayer costs.

8) Government Accountability Office, Superfund: Information on the Nature and Costs of Cleanup Activities at Three Landfills in the Gulf Coast Region (February 18, 2011)(GAO-11-287R),pp. 2, 5-11. (http://www.gao.gov/new.items/d11287r.pdf)
This report reviews superfund cleanup costs from hurricanes and natural disasters that spread toxic wastes and debris from existing superfund sites, resulting in contaminated landfills and new superfund sites. It also points out that while leaving toxic wastes on site at a superfund site is inexpensive, that if there is a natural disaster the resulting clean-up costs are high. Three landfills on the Texas Coast cost an estimated $13-$55 million each to clean up from debris from natural disasters.

9) Gaddis, Miles et. al., 63 Ecological Economics, Full Cost Accounting of Coastal Disasters in the U.S. (2007), 307-318 (http://www.sciencedirect.com/science/article/pii/S0921800907000985)
Looking at Hurricane Katrina, this report notes that the true societal costs of hurricanes extend beyond typical building costs and human costs to ecological and health costs from toxic contamination from industrial and superfund sites. The report notes there were 26 superfund sites in the path of Katrina and that massive amounts of toxic wastes, oil and debris were dispersed by the Hurricane, greatly impacting the environment and aquatic eco-systems. In one example, Hurricane Katrina's winds and flooding were strong enough to topple a 250,000 barrel metal storage tank, causing a large oil spill--showing the power of hurricanes to disperse toxic chemicals in their path.

10) Hayes, American Association of Petroleum Geologists Bulletin, Vol. 51, No. 6, Hurricanes as Geological Agents on the South Texas Coast (1967), pp 937-956 (http://archives.datapages.com/data/bulletns/1965-67/data/pg/0051/0006/0900/0937.htm). This study looks at the impact of the massive Hurricane Carla in 1961 and the smaller Hurricane Cindy in 1963 on Padre Island. The report noted that there were an average of .67 hurricanes on the Texas Coast with 42 hurricanes between 1900-1963. It found Hurricane Carla moved rocks and materials from as deep as 50-80 feet from the ocean to the beach and dunes. It also indicated that foredunes were moved as far as 100 feet as well as barrier flats suffering massive erosion.

11) Islam et. al., Natural Hazards Review, Vol 10, Origin, Distribution and Timing of Texas Hurricanes, 1851-2006 (2009), pp.136-144 (http://ascelibrary.org/doi/abs/10.1061/(ASCE)1527-6988(2009)10:4(136),
From 1851-2006, 104 tropical storms or hurricanes hit the Texas coast, with 66 being hurricanes and 24 being major hurricanes. 64% of the hurricanes hitting the Texas Coast were Categories 1 and 2, and 36% were categories 3 and 4 (no Category 5 hurricanes have hit yet). The upper Texas Coast and Galveston Bay is the area most prone to hurricanes on the entire Texas coast because of various natural phenomenon, with 56% of all hurricanes hitting the Upper Texas Coast and Galveston Bay. These hurricanes are also the strongest that hit the Texas coast.

12) Clarke et. al., Risk Analysis, Vol. 24. No. 3, Engineering Containment and Control Systems: Nurturing Nature (2004), pp. 771-779 (http://onlinelibrary.wiley.com/doi/10.1111/j.0272-4332.2004.00474.x/abstract). This report states that capping and lining is not a long-term solution, since over time these approaches will degrade over time, likely within 50 years. The result will be much high costs to remediate and cleanup to society. The remedy must be appropriate for the site in question and adapted to the particular environment, its health and environmental risks, and the long-term costs over time of continued contamination from future remediation degradation and costs of monitoring.

13) Boruff et. al, Journal of Coastal Research Journal, Erosion Hazard Vulnerabilities of US Coastal Counties, Vo1. 21, Issue 5 (2005), 932-942 (http://jcronline.org/doi/abs/10.2112/04-0172.1)
This report indicates that coastal erosion analysis has focused primarily on physical factors (land forms, hydrology, and buildings), but that social factors, such as the level of poverty and demographics, also pay a large role in the analysis of the economic, environmental and human costs of erosion. Because of the greater poverty and other demographics of the Gulf Coast, social factors play a larger role in the erosion cost analysis on the Gulf Coast than other US coasts.

14) Marritz, New Jersey Public Radio, Concerns Grow Over Flooding from a New Jersey River That is also a Superfund Site (November 13, 2012)
(http://www.wnyc.org/story/250565-concerns-grow-over-flooding-river-s-also-superfund-site/) When the Passaic River in New Jersey has flooded from Hurricane Sandy and other storms, its waters have overflowed causing leakage of dioxin and PCBs from a superfund site on the River's banks. Scientists worry that dioxin and PCBs were transported to residences and deposited in people's basements, posing health risks.

15) Cooperating Parties Group, River Mile 10.9 Removal Action Pre-Final Design Project, Lower Passaic River Study Area (November 2012)(http://www.ourpassaic.org/ProjectNews.aspx). The EPA and cooperating parties agree to remove 18,000 cubic yards of contaminated sediments containing dioxin and PCBs from the banks of the Lower Passaic River to protect public health and the environment. After the toxic wastes are remove and moved to a permitted disposal facility, the site will be treated and capped.

16) Farley, WNET New York Public Radio, Four Toxic Rivers: A Super Sad True Superfund Story (November 11, 2011) (http://www.thirteen.org/metrofocus/2011/11/four-toxic-rivers-a-super-sad-true-superfund-story/)
This article discusses four superfund sites in New York area rivers. It notes that 200,000 cubic yards of toxic wastes, containing PCBs and dioxin, were dredged and removed from the Lower Passaic River. To prevent further toxic waste dispersion into the river during excavation, the site was enclosed by a giant barrier. In addition, a pipeline was built to transport the wastes from the superfund site to a disposal facility.

17) EPA, Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (2005), pp. 2-27 - 2-19, 5-2 - 5-6, 6-1 - 6-29 (http://www.epa.gov/superfund/health/conmedia/sediment/guidance.htm)
This EPA manual notes that the most common superfund site remedy is dredging and excavation of toxic wastes and that this approach removes uncertainty of future toxic waste exposure when risks of erosion or extreme events exists. In deciding an appropriate remedial action, it points out that routine, repeated forces, such as waves, currents and tide, can erode caps over time. It also notes that the frequency and intensity of extreme events, such as hurricanes and flooding, must be taken into account for determining an appropriate remedy. It notes that containment barriers, such as sheet piling and cofferdams, are used effectively to prevent further dispersion of toxic wastes into the water during the removal process.

18)Center for Health, Environment and Justice, Superfund: in the Eye of the Storm (June 2010)(http://chej.org/wp-content/uploads/Superfund-In-the-Eye-of-the-Storm-REP-013.pdf)
This study notes that 56 superfund sites on the Gulf Coast were adversely impacted by extreme weather events between 2004 and 2008. Climate change is causing more frequent and intense extreme weather events, such as hurricanes, flooding, and tornados, which are causing an increased threat to the integrity of superfund sites and the public health and environment.

19) Blackburn and Bendit, Learning the Lessons of Hurricane Ike (May 2010)
(http://sspeed.rice.edu/sspeed/downloads/SSPEED_Interim_Report_2010.pdf)
This report from Rice University's SSPEED Center that the significance and destructive force of hurricane storm surges are significant and serious destructive force that is not fully appreciated and that their destructiveness and power are seriously underrepresented in the engineering literature. Hurricane surges, combined with rainfall, are an under-examined phenomenon and pose a worsening risk to the Houston area and coast.

20) Brody, Sam. *A Flood Risk Assessment of the San Jacinto River Waste Pit Superfund Site*. Texas A&M University Galveston: , 2014.